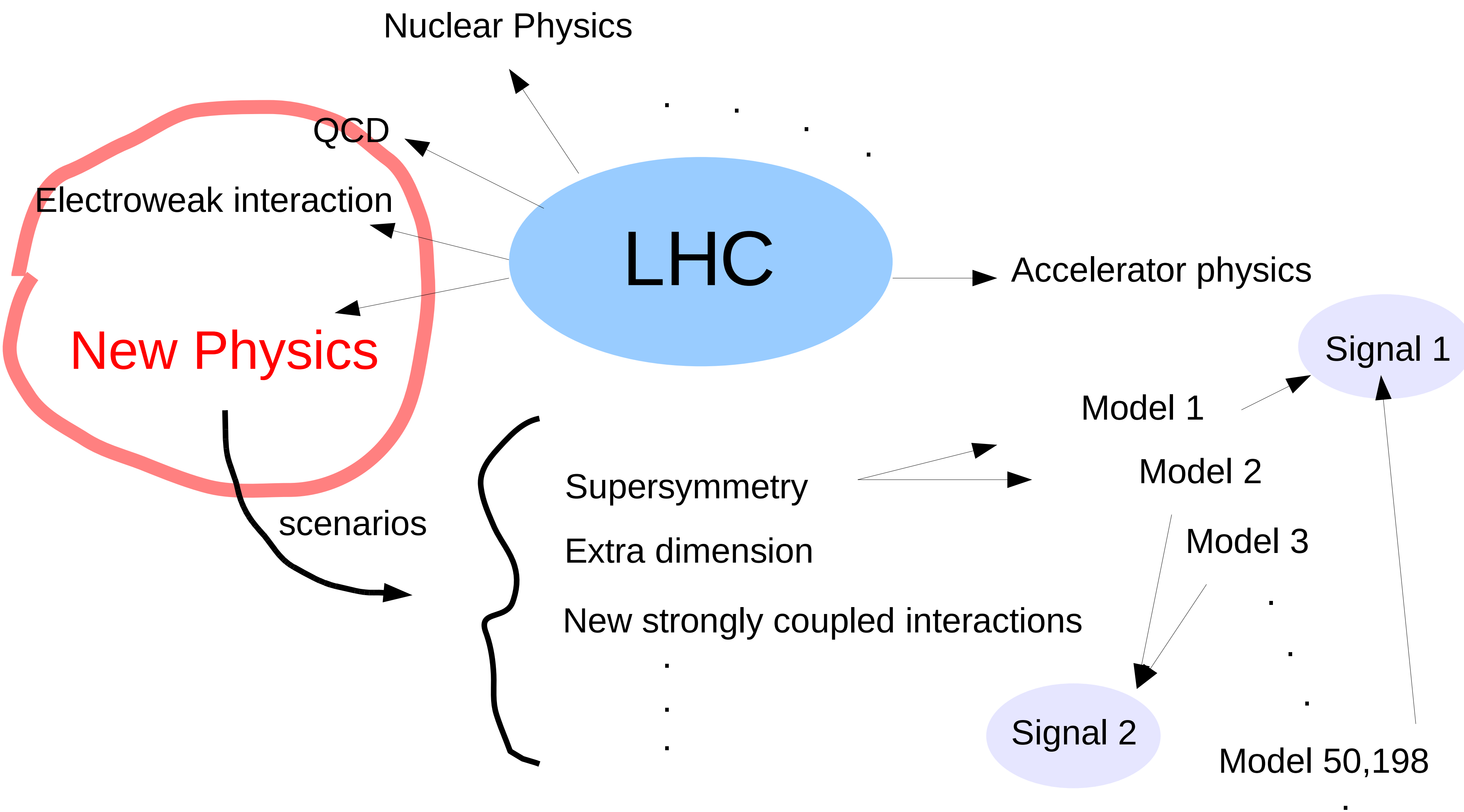
My interest related to Jet Physics

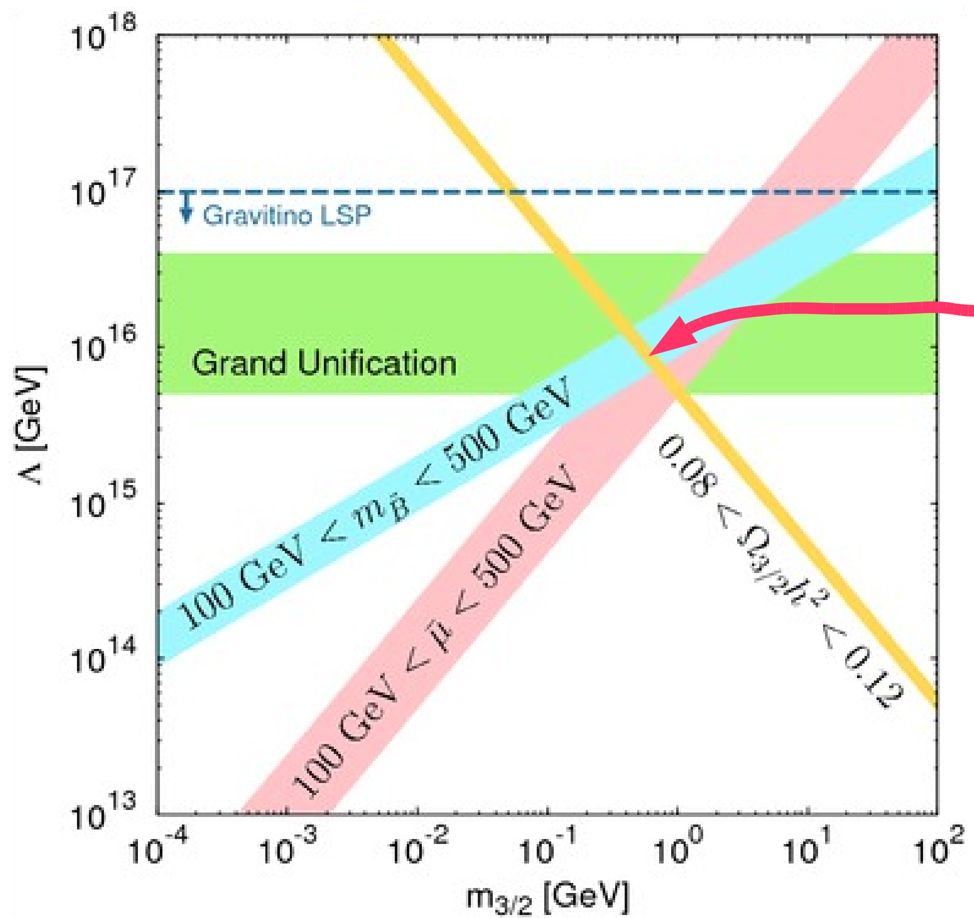
Ryuichiro Kitano (T-8)

Presentation at LANSCE 9/26/07



We need models (theoretical framework) to study/discover those scenarios at the LHC.

Recent progress in supersymmetric model building:



Perfect spot!

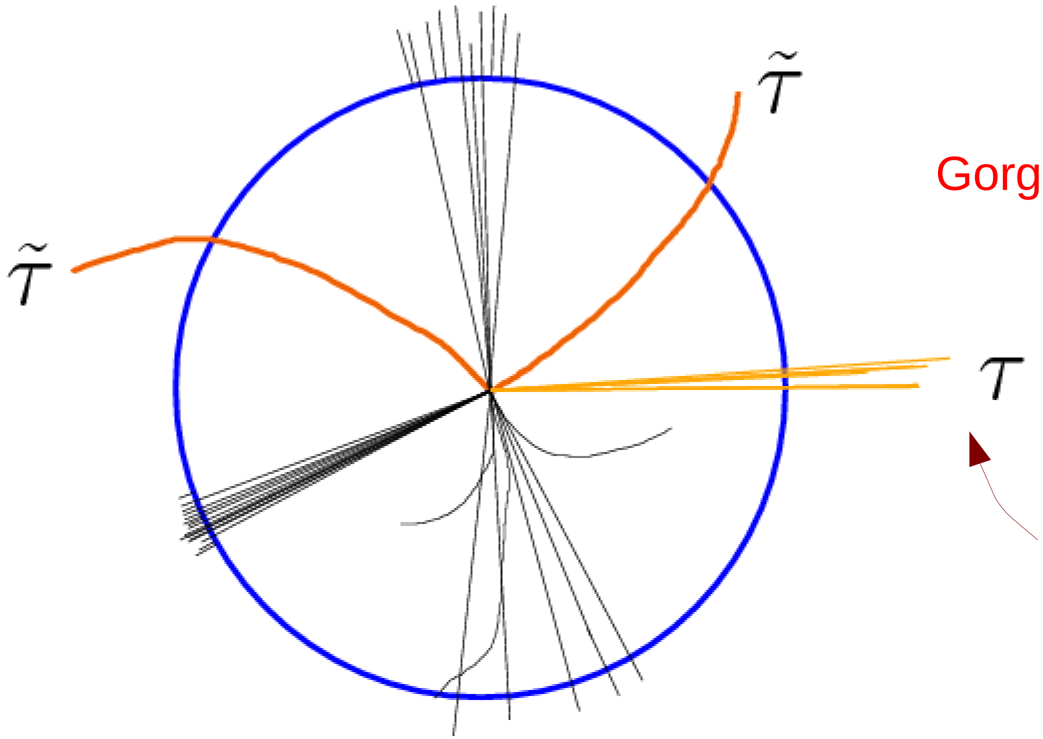
Grand Unification
gravitino dark matter
no FCNC problem
no CP problem
no moduli/gravitino problem
no mu-problem

Completely successful model!!

We've gotta study this!

Interesting prediction of this theory @ LHC

- (almost) stable charged particle (stau) with mass of O(100GeV)
- Two slow charged tracks for each supersymmetric events (~pb)!!



Gorgeous events

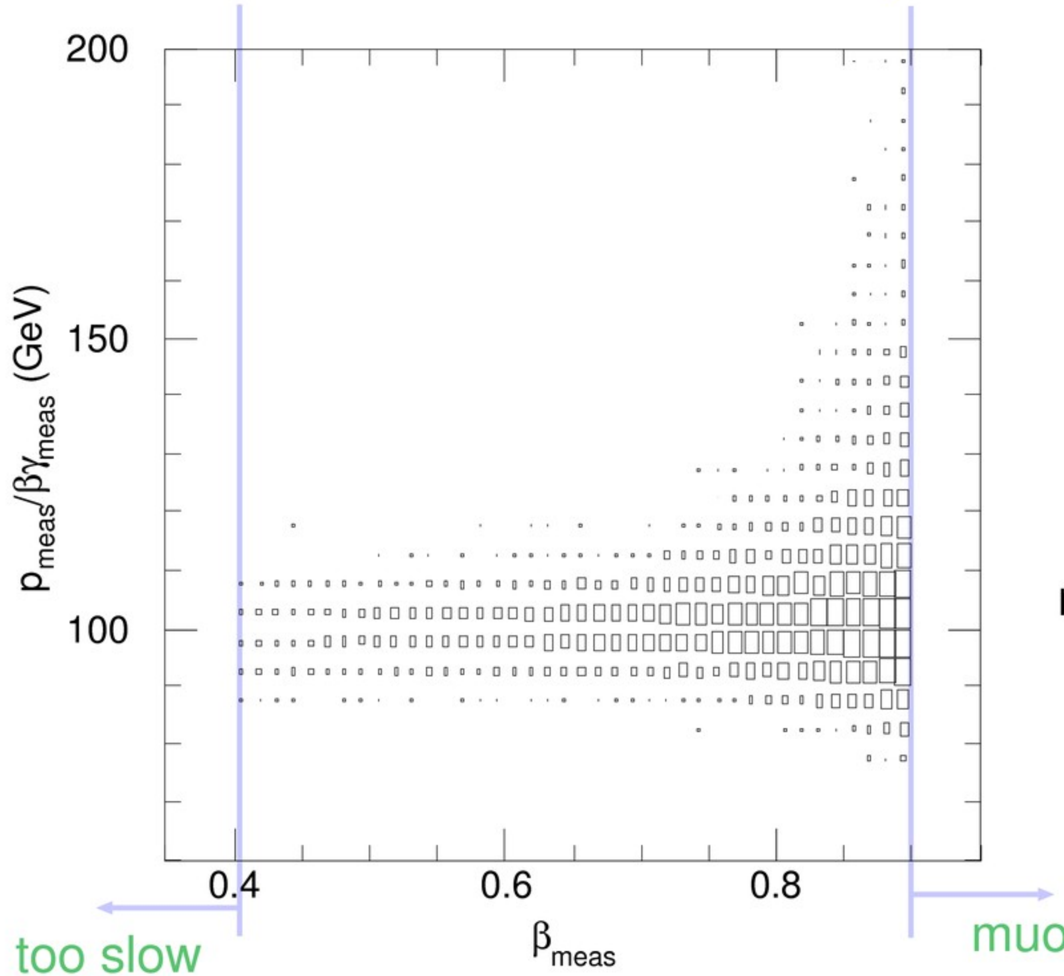
Typical events contain associated τ-jet.

Can we distinguish from a muon pair?

Stau mass measurement at LHC

[Ambrosanio, Mele, Petrarca, Polesello, Rimoldi '00]

stau is almost stable (lifetime=O(1000s))



$$m_{\tilde{\tau}} = \frac{p_{\tilde{\tau}}}{\beta\gamma}$$

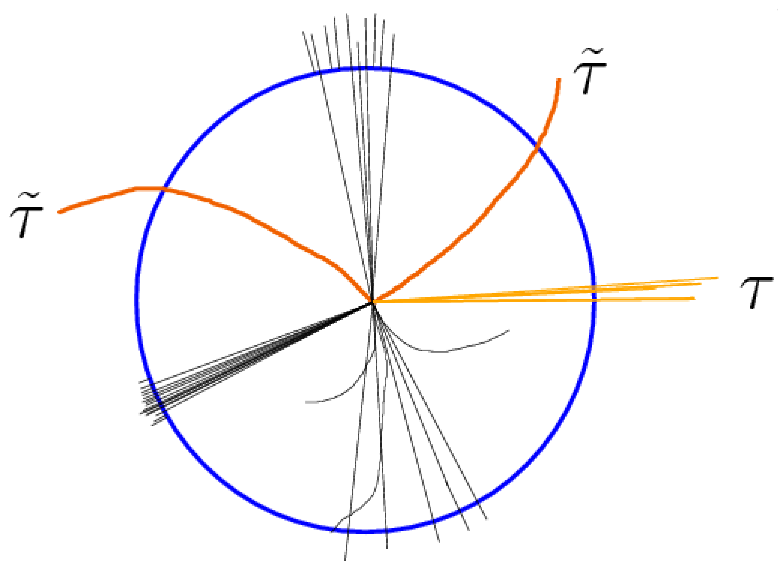
measure momentum and velocity.

resolution of the velocity is rough

$$\frac{\sigma(\beta)}{\beta} = 3\% \times \beta$$

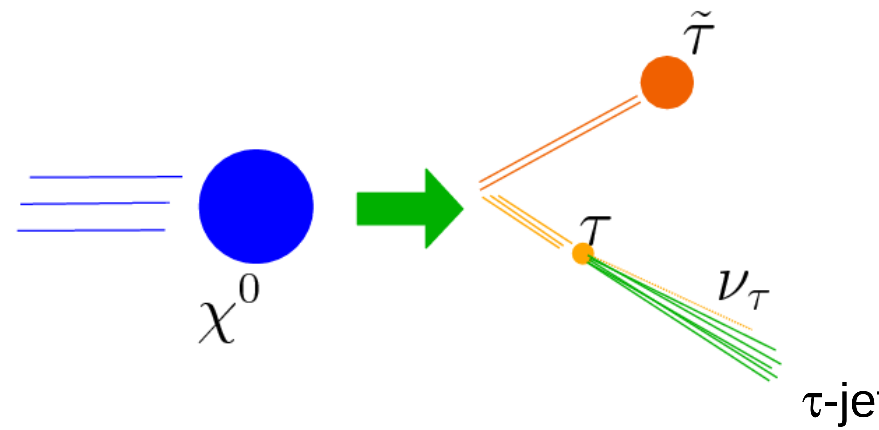
stau mass can be measured with an accuracy of 100MeV!!

Extracting information on SUSY models



Invariant mass of this combination gives a neutralino mass.

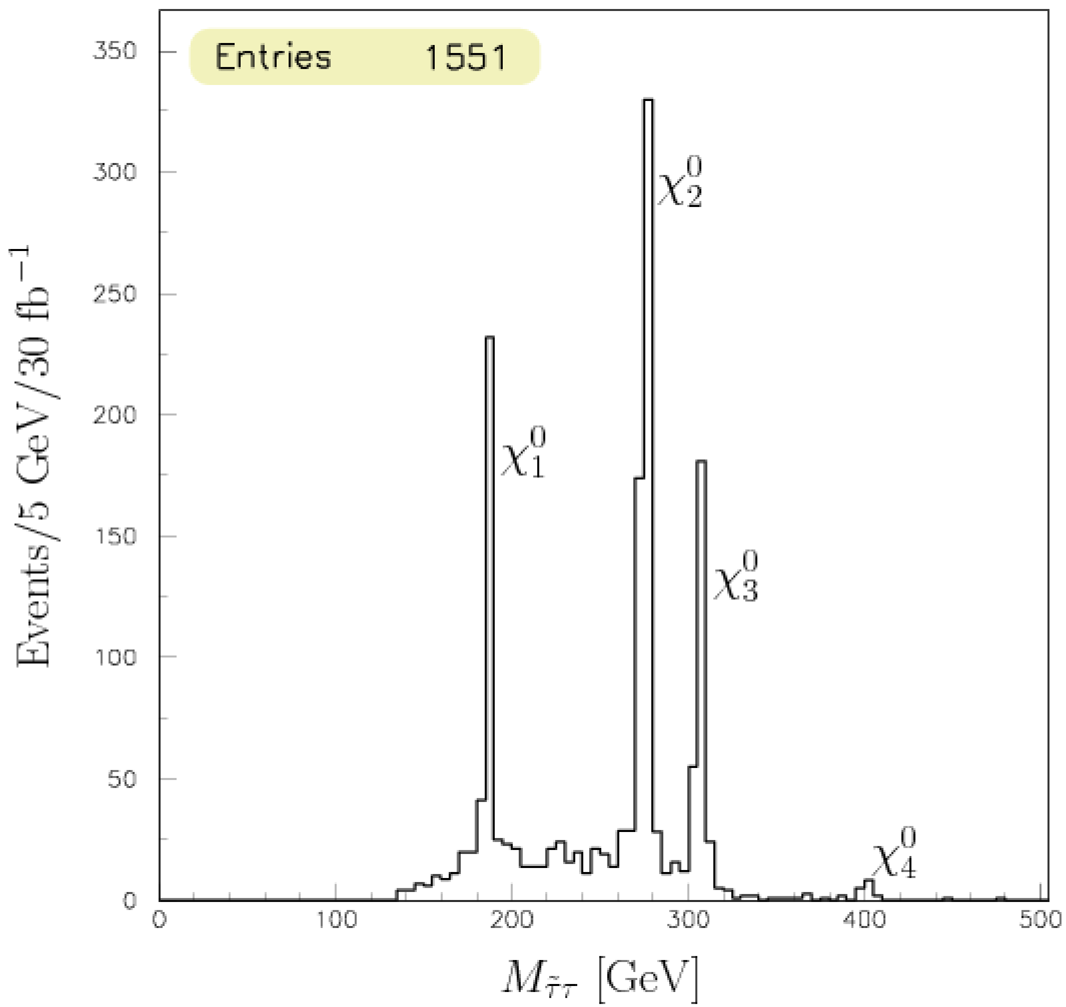
because



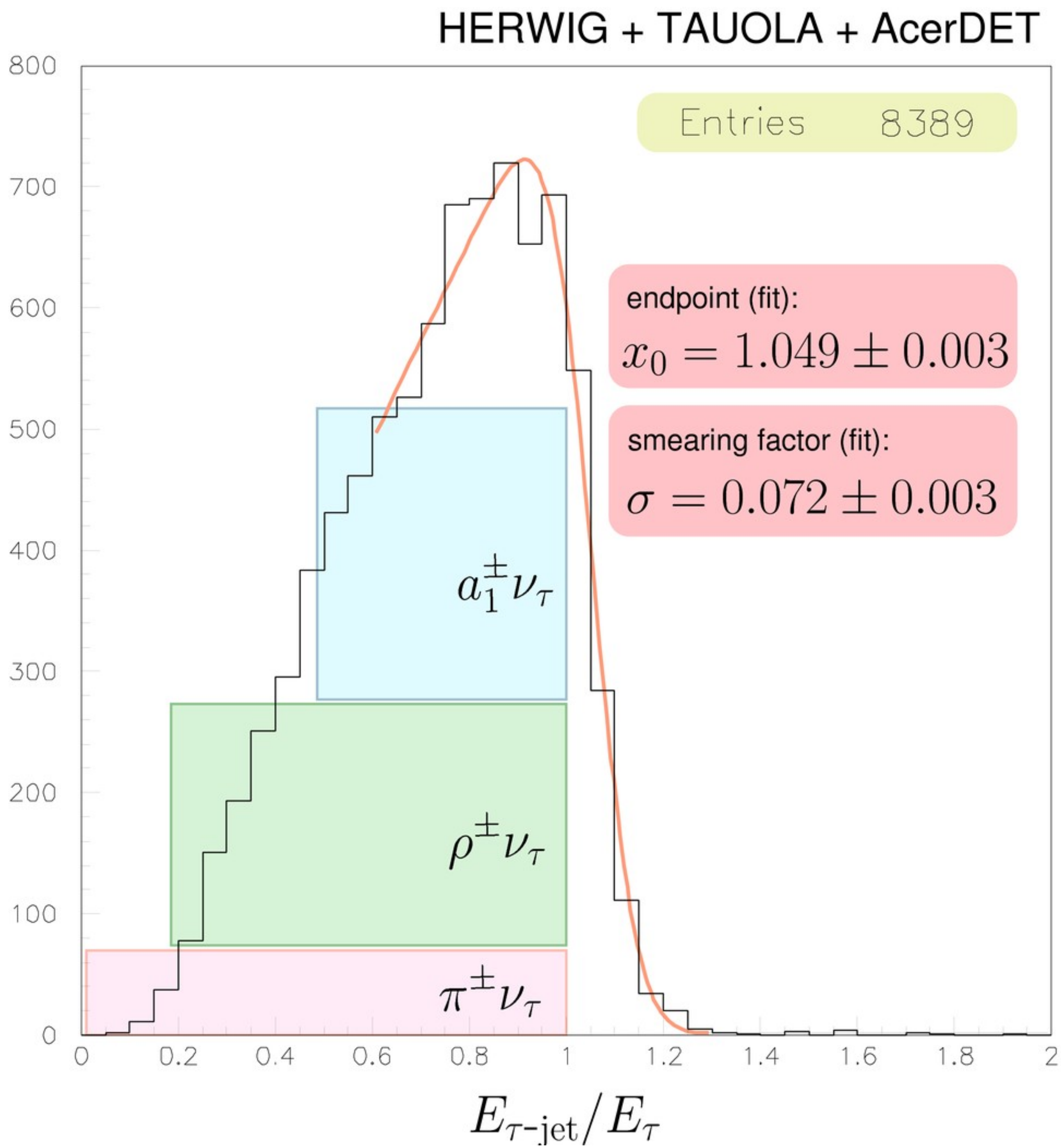
However, always a neutrino is escaping

We don't know the energy of tau!!

If we knew the τ-energy, we could see



tau energy?



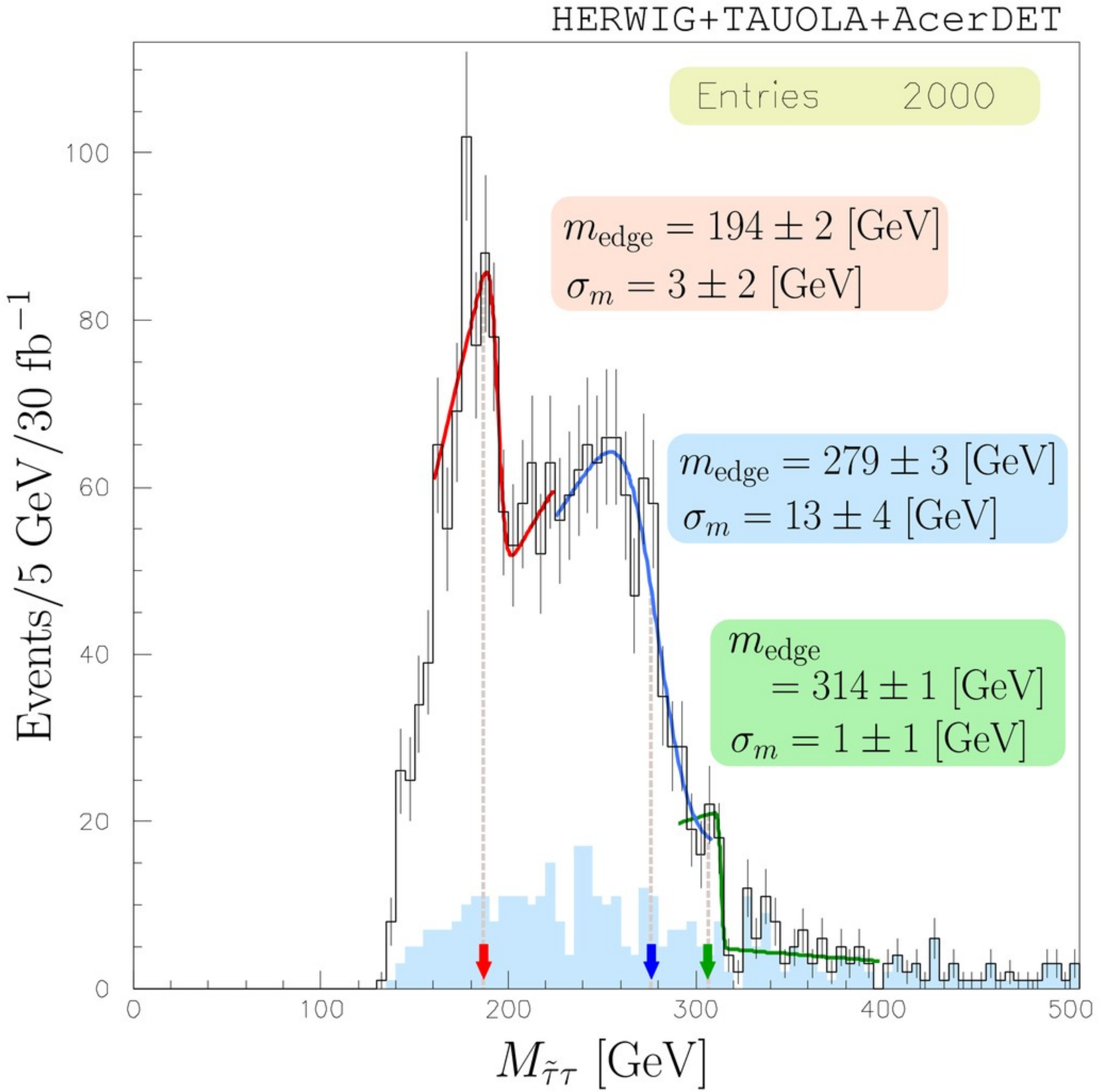
there is a sharp edge
at E(jet)/E(tau)=1

The shape is understandable
from 2-body kinematics

thresholds at meson
masses are smeared
by the finite widths of mesons

We can expect sharp edges
at neutralino masses
in the M(stau-tau) distribution.

Invariant mass



We select stau which gives a smaller value of the invariant mass.
(efficiency = 70%)

We can clearly see the edge structures.

main background is wrong combination and tau mis-identification.

We can measure
$m_{\chi_1^0}, \ m_{\chi_2^0}$
with an accuracy of O(5%)

From $m_{\tilde{\tau}}, \ m_{\chi_1^0}, \ m_{\chi_2^0}$ all the parameters can be fixed.

→ Lot's of predictions!!!

This is something theorist could do. But for more realistic analysis, we need to understand physics of τ-jet identification including probability of misidentification of light jets etc.

Current and Future interest

Why do we think LHC is exciting?

→ Because it may reveal the mystery of the Higgs sector.

→ Yes. New physics must be tightly connected with the physics of the Higgs particle.

We know that Higgs particle has strongest interaction with the top quark.

→ Yes. New physics must be tightly connected with the physics of the top quark.

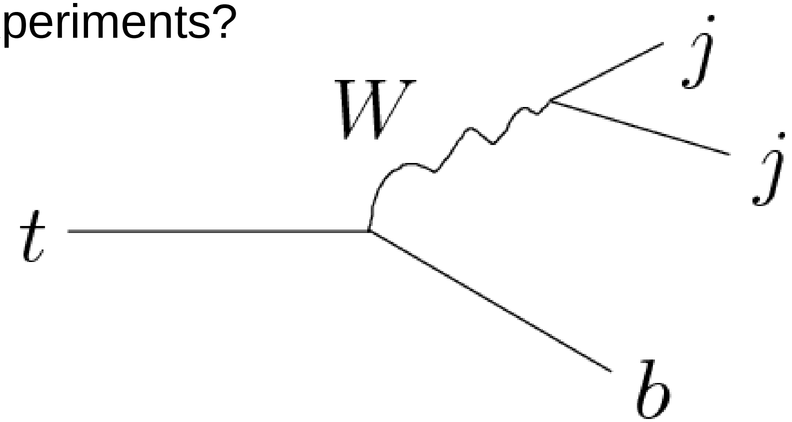
Then...

I think it is very important to study "Top quarks in new physics events."

Actually, in my model, we expect lots of top quarks in each supersymmetric events.

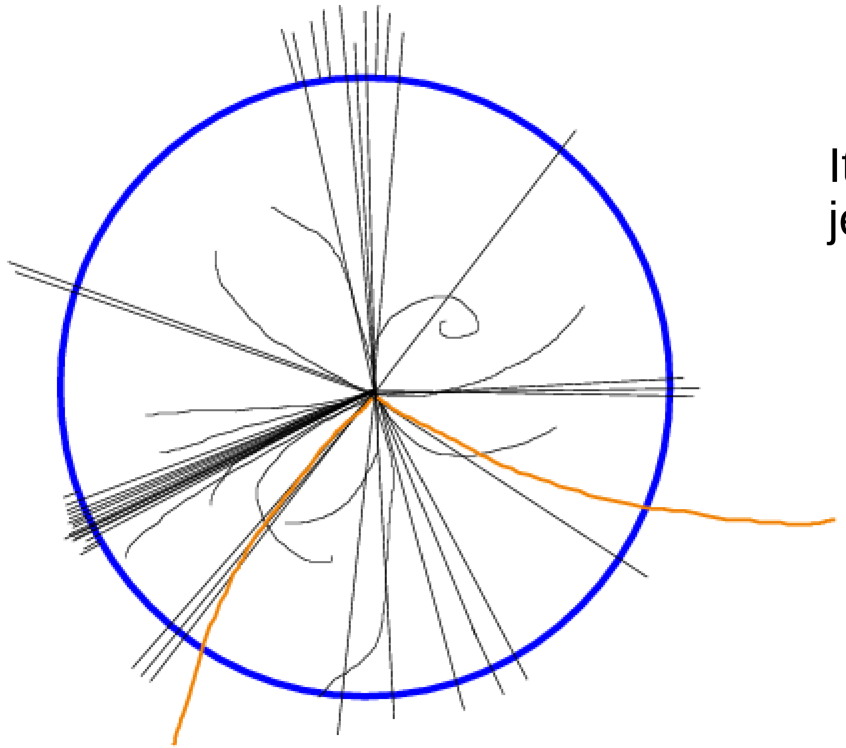
What is the top quark in collider experiments?

It is 3-jets.



The first step study:

Can we find (multiple) top quarks in new physics events?

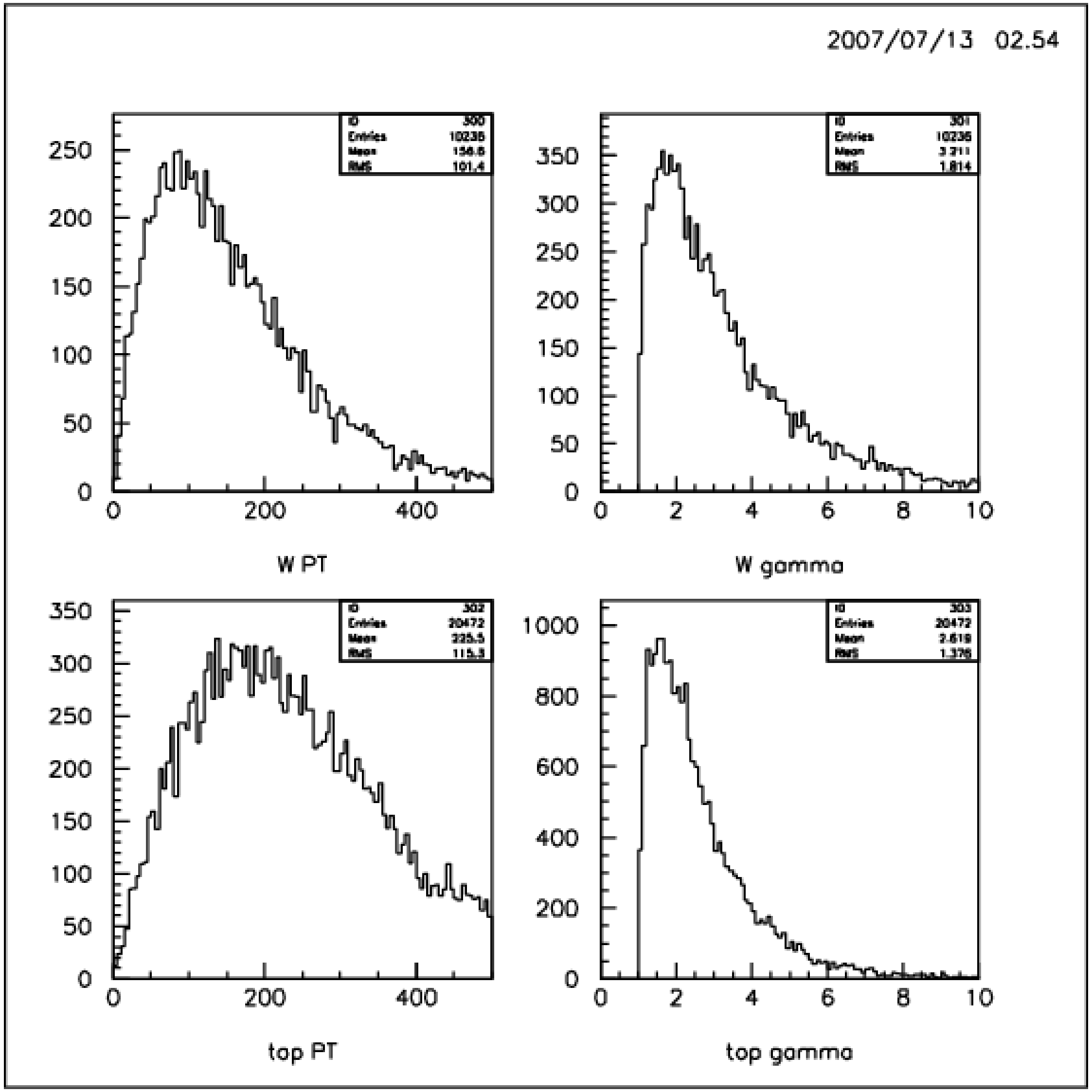


It's not easy. There is a difficulty in identifying jets coming from top quarks.

Likelihood analysis?
Using jet mass analysis?
W-jets?
top-jets?

Which combinations of three jets are the top quarks???

Work in progress...



There are number of highly boosted W bosons.

→ Top quark becomes 2-jets!

This may be useful in identifying top quarks.

Summary

I think

Understanding the third-generation fermions, τ and top, is very interesting and important in the LHC experiment.